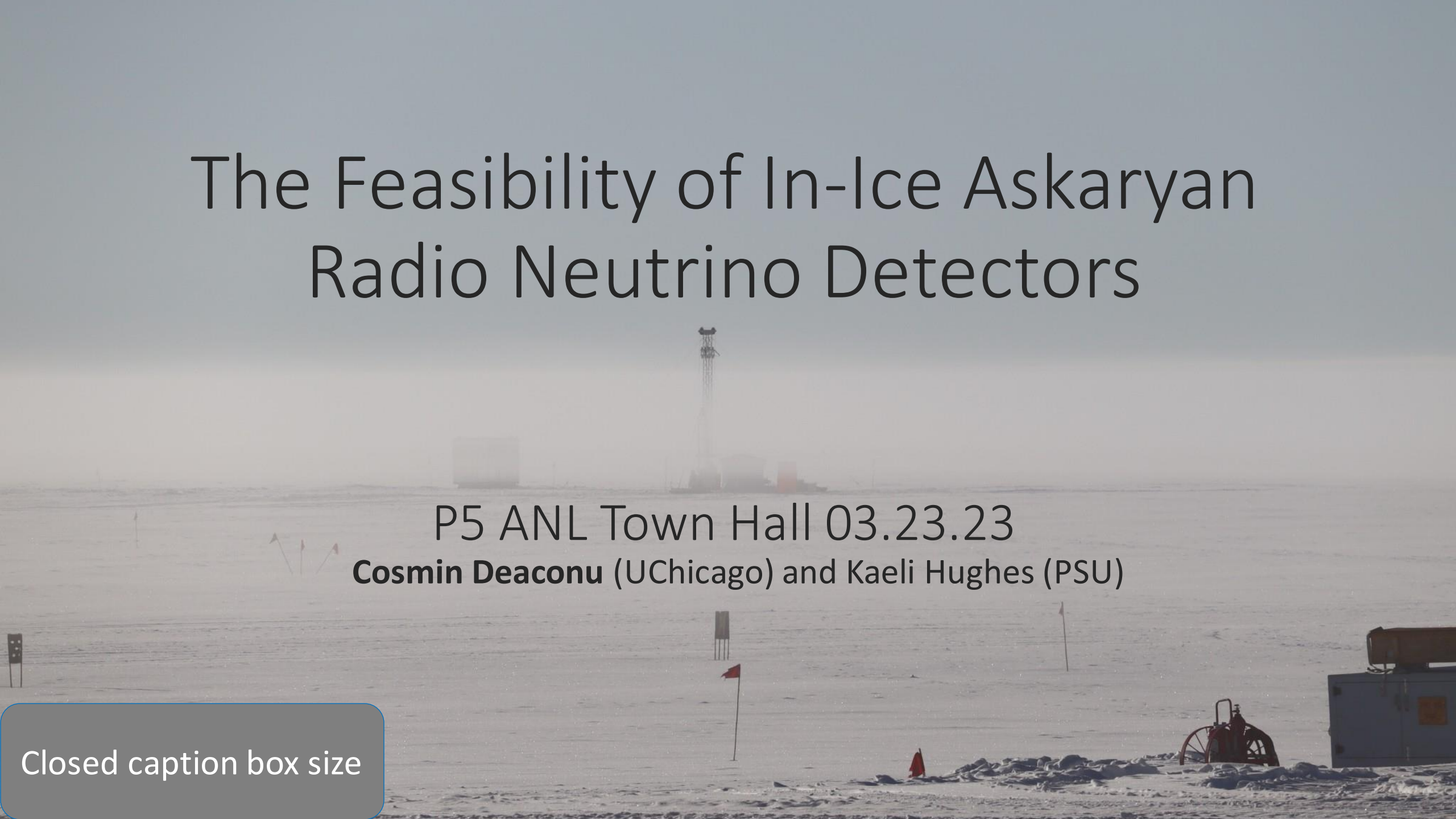
The Feasibility of In-Ice Askaryan Radio Neutrino Detectors

P5 ANL Town Hall 03.23.23

Cosmin Deaconu (UChicago) and Kaeli Hughes (PSU)



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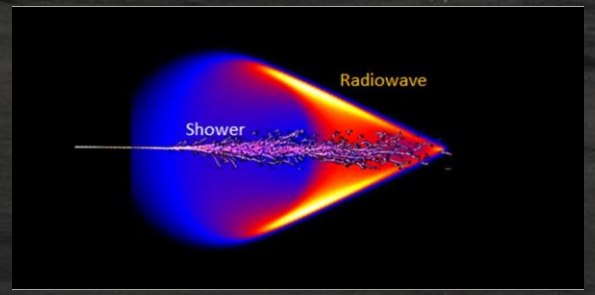
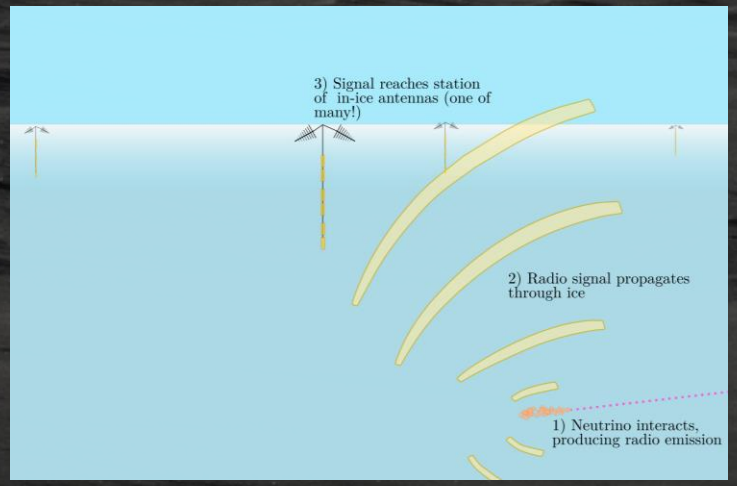
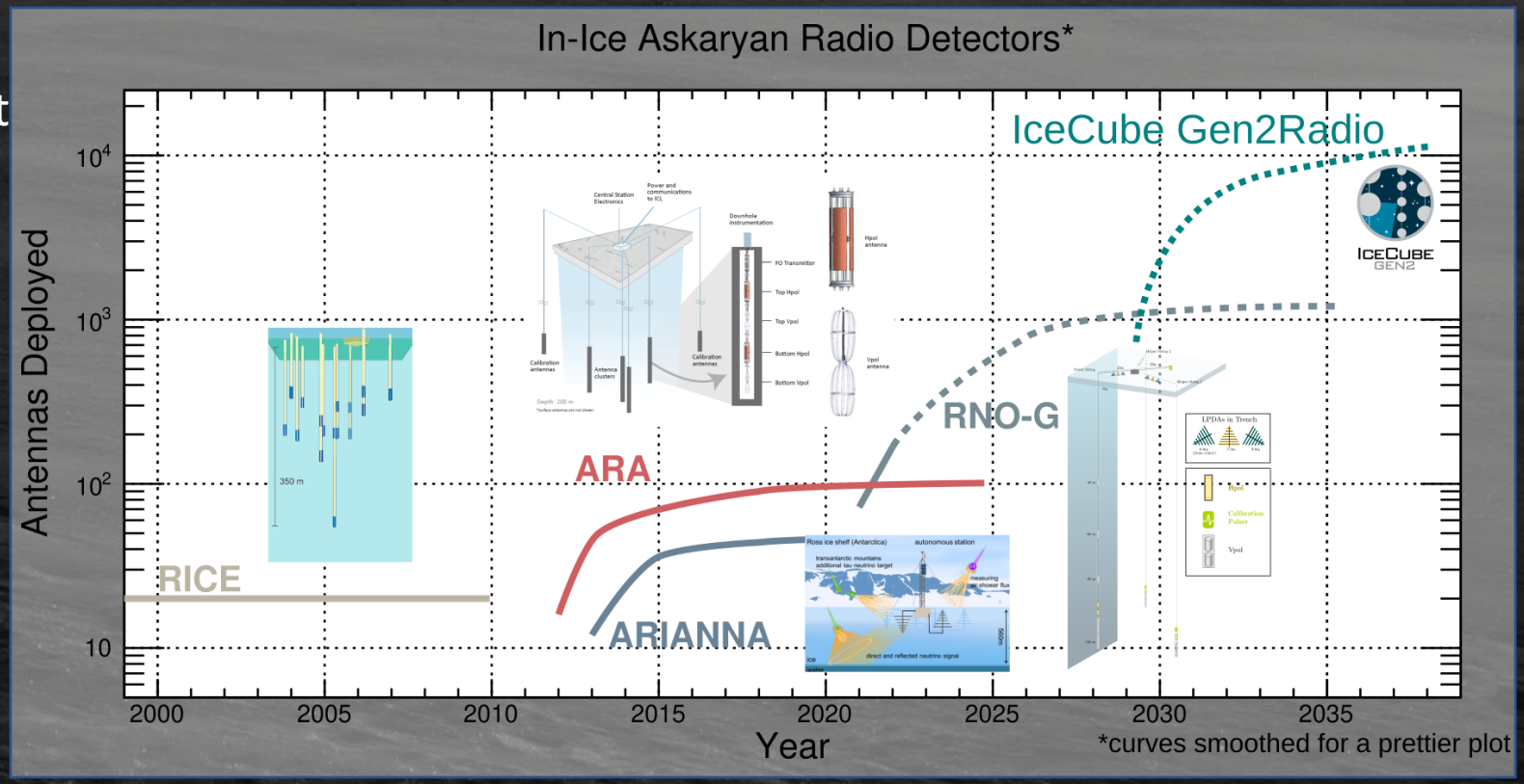
In-ice Radio Detection of UHE Neutrinos

- In-ice Askaryan radio detectors measure radio emission from neutrino-induced cascades in radio-transparent polar ice, allowing efficient instrumentation of the large volumes necessary to detect UHE (>100 PeV) neutrinos.
- Following pioneering work by earlier detectors (RICE, ARA, ARIANNA), the first mid-scale in-ice radio neutrino detector (RNO-G) is now being constructed.
- Detecting significant numbers of UHE neutrinos under many flux models will require a very large detector, like IceCube Gen2Radio.
- We believe that all the pieces are in place for a large-scale detector







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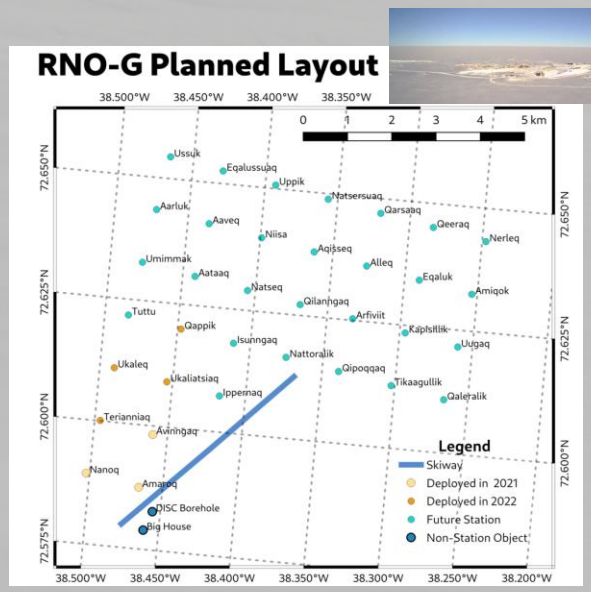
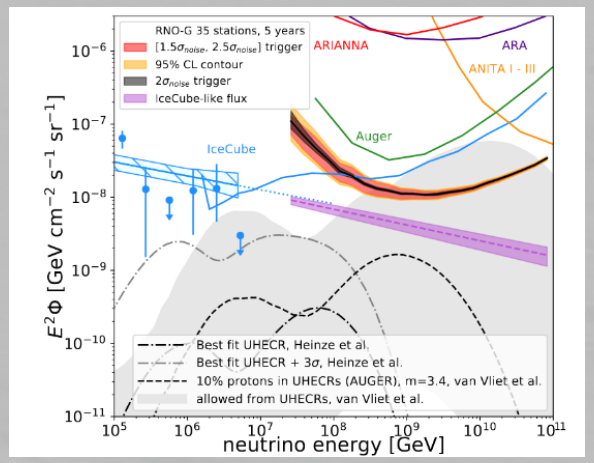
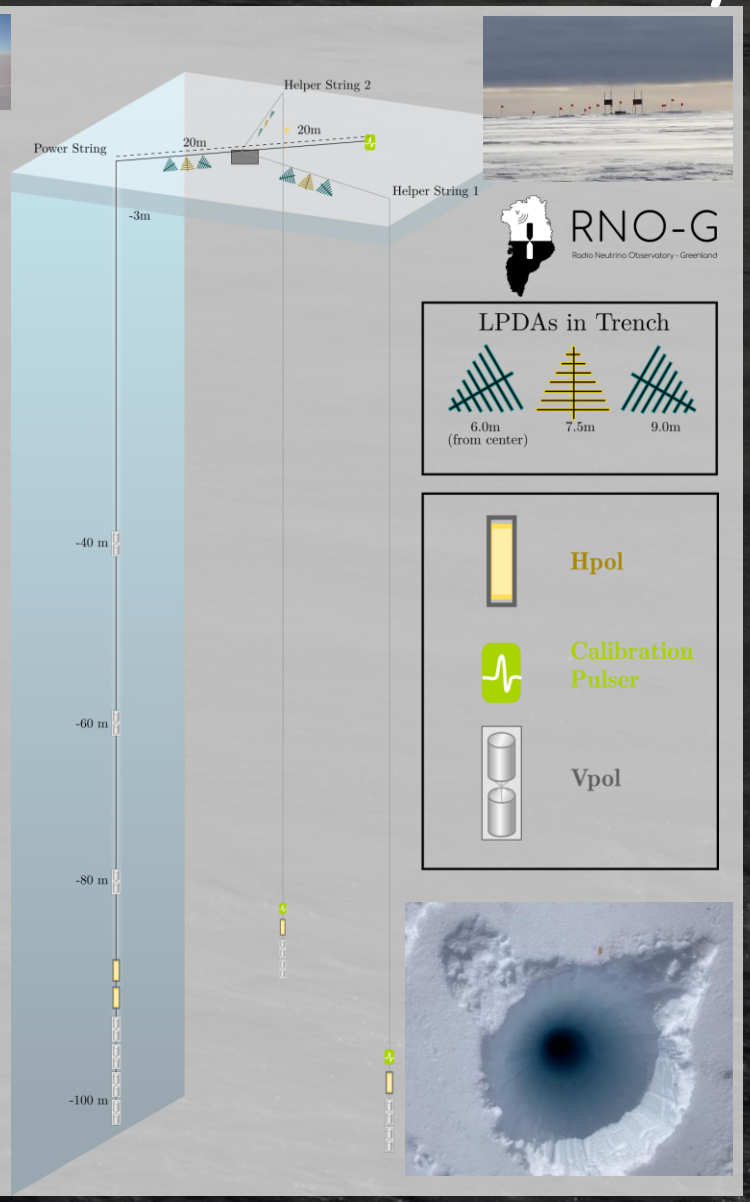
RNO-G demonstrates the scalability of in-ice radio







- The Radio Neutrino Observatory – Greenland (RNO-G) is a radio array being deployed in the Greenlandic ice sheet near NSF's Summit Station
- RNO-G is the first mid-scale Askaryan detector and has a realistic chance to detect the first UHE neutrinos.
- RNO-G has significant heritage from earlier experiments but has implemented significant advances in scalable electronics, deployment and operations.
- Optimized "hybrid" station design with 15 deep and 9 shallow antennas serves as the basis of the IceCube Gen2Radio design.
- International collaboration (US, BE, DE, SE, NL)

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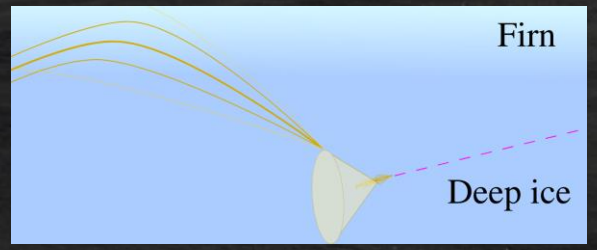
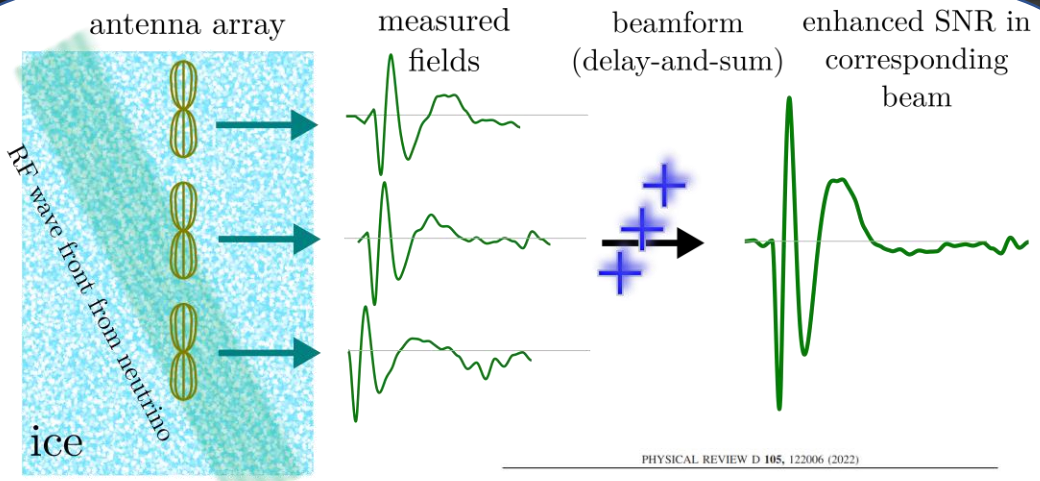
Reducing the energy threshold with phased arrays

- Deep antennas are more sensitive (due to ray-bending in shallow ice), but high-gain antennas don't fit in boreholes.



- Solution: synthesize high-gain antennas in boreholes using electronically-steered phased arrays to lower detection threshold, increase visible volume.
- Technique demonstrated at Pole with prototype as part of ARA; adopted as main-trigger by RNO-G, PUEO and IceCube Gen2Radio.
- Proof-of-concept analysis of ARA prototype demonstrates existence of low-background searches with high analysis efficiency.



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Low-threshold ultrahigh-energy neutrino search with the Askaryan Radio Array

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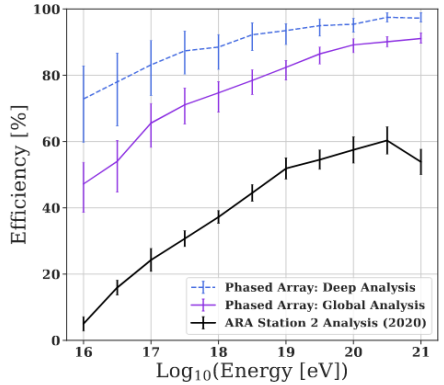
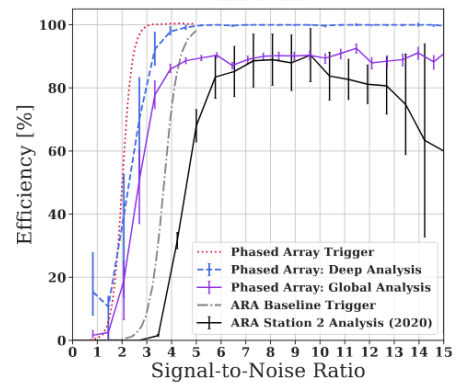
(ARA Collaboration)





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